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CONTRIBUTIONS OF PHARMACOLOGY TO PHYSIOLOGY.[1]

LADIES AND GENTLEMEN: Before I enter upon the task for which I ask your kind attention, I desire to express my hearty thanks for the great honor you have extended to me in inviting me to deliver the Herter lectures. The honor I accept, not so much for myself as for the science which I represent.

Experimental pharmacology is a science with essentially theoretical aims—a part of general biology, in which there is nowhere shown a greater interest than in America. I take especial pleasure in asserting that in this land of varied successes the understanding of abstract problems and of purely theoretical work thrives and ever grows, always extending to wider circles, filled with a scientific idealism which invites the most splendid and admirable sacrifices, spiritual and material. Your famous university and, indeed, these lectures themselves owe their origin to such idealistic impulses. And this gives me the courage and the desire to talk to you of the significance and value of pharmacology.

It is, then, not necessary for me to claim your attention for the practical results or for their value to the practising physician; not, however, that I undervalue this important side of pharmacology. But may I not hope at this place to be able to attain my purpose most easily, if I beg your attention to the biological results which we owe to pharmacological investigations?

For the explanation and analysis of physiological function, apart from comparative physiology, stimulation and extirpation of certain organs or parts of organs serve as general methods. Experimental physiology employed to this end mechanical

[1] Being the first of the Herter lectures delivered at the Johns Hopkins Medical School, October 5, 1905.

and physical means almost exclusively. The scalpel and scissors, electrical, thermal and mechanical stimuli have long served its purposes. The manifold means of chemistry have scarcely been utilized. Its appliances and its study belong, indeed, to pharmacology, which is, as an American fellow-worker has tersely said, 'the experimental chemistry of protoplasm.'

The drugs, that is the chemical reagents, penetrate into the interior of the organs and reach parts which are not accessible to the scalpel and the electric current. Indeed, the differential action of poisons—that which has to do with single parts of organs or single especial groups of cells—is the important part of the pharmacological method. But we must concede that it has not attained for the most part the undoubted certainty and clearness of physiological methods, for every drug which we wish to use as an instrument of investigation must first itself be investigated, its mode of action first be recognized and determined. You all know well how difficult and equivocal such investigations are, and it is easily intelligible that, especially in the beginnings of such investigations, while there was no large array of pharmacological facts supporting one another, one scarcely ventured from these to draw far-reaching conclusions.

An interesting example of this sort is the admirable investigation of Felice Fontana on Indian arrow poison, which was carried out more than one hundred years ago. Fontana was forced to the conclusion, through ingenious experiments, which resembled the much later ones of Claude Bernard, that the arrow poison paralyzes neither muscle itself nor the whole nerve, but only the endings of the latter and that, indeed, the latter must possess a structure different from the nerves themselves, of which anatomy and physiology took no cognizance. Fontana, however, did not dare to draw the right conclusion because the proof was indeed a pharmacological and not an anatomical one. Only much later was it learned that properly conducted and correctly interpreted pharmacological experimentation possesses the same power of conviction as any other exact scientific method. And it is precisely the curara poison which has led to positive physiological discoveries. By its help Boehm and Nussbaum, through the discovery of the so-called paradoxical vagus action, discovered the vasopressor nerves and the accelerator fibers in the trunk of the vagus nerve in dogs and cats; and later, with the help of the same poison, Boehm obtained the proof, otherwise inaccessible to physiology, that the nerve endings in the muscles possess the same capacity for fatigue and recovery as the muscle itself. The important problem of the close connection between the irritability and the conductivity of nerves was not soluble except by the aid of the pharmacological method, that is, the methodical utilization of poisons like curara, veratrin and carbon dioxide.

Formerly it was impossible to detect any physiological or morphological difference either in the arrangement or in the general structure of centrifugal and centripetal nerve tracts. But the narcosis experiments of Fraser, Alms, Joteyko and especially the more recent ones by Dixon with cocain, showed that they must be chemically different from one another, inasmuch as they react differently to poisons.

Highly important, also, are the physiological results which Langley obtained with the help of nicotin poisoning in relation to the sympathetic ganglia. He was able to show that by means of nicotin the sympathetic ganglia, and through them all the preganglionic nerves, were paralyzed, while the post-ganglionic nerves escaped. So it is possible to decide by this means

whether a nerve ends in a sympathetic ganglion or passes through it, as is the case, for example, with the trigeminus fibers through the ciliary ganglion.

The study of the action of a wholly different type of poison, namely tetanus toxin, has also furnished a series of important facts relating to the field of neurophysiology. If one injects into an extremity of a warm-blooded animal a sterile toxin derived from tetanus bacilli, there occurs, as is well known, a local tetanus, that is to say, the inoculated limb enters into tonic extension and shows, especially in the later stages of the poisoning, an increased reflex irritability, while all the remaining parts of the body continue to retain their normal position and normal reflex excitability. Now, it was possible to show that this remarkable phenomenon arose through the circumstance that the poison was absorbed by the adjacent motor nerve-ends and carried upward in the axis cylinder to corresponding centers of the spinal cord. The blood and lymph channels are wholly unconcerned in this transportation of the poison, and there consequently remains only the possibility that there is constantly flowing through the axis cylinder of the motor nerves a centripetal protoplasmic stream, reaching as far as the ganglia of the neurones. This was a previously unknown fact which must be of significance for the nutrition of the nerves and also for the trophic disturbances of the central ganglia which develop after section of the peripheral nerves. I have also found that such a centripetal flow of diphtheria toxin occurs in the nerves and the same thing seems to be true of certain metals which, like lead, give rise to chronic neuritic palsies. Perhaps a stream of this kind passes also along the sensory nerves, but in any case its course is arrested by the spinal ganglia, so that the tetanus poison is here held fast and is unable to reach the sensory apparatus of the spinal cord. If, on the other hand, one injects the posterior nerve-roots between the root ganglion and cord, there occurs an irritation of the sensory pain-exciting apparatus in the spinal cord and, indeed, without simultaneous irritation of motor or reflex structures. There thus arises the pure so-called tetanus dolorosus, which is characterized by the periodical recurrence of extremely painful seizures, excited apparently through the summation of minimal and, ordinarily, wholly inactive stimuli. It makes no difference, as regards the development of the phenomenon, whether the spinal ganglion has or has not been removed—a fact which was shown by Fletcher. In this manner has arisen the proof of the existence of wholly special pain-subserving structures in the central mechanism of the spinal cord (the existence of which was long denied by French physiologists)—structures distinct from those subserving tactile and motor functions.

Finally these investigations have brought to light another remarkable fact. In the ordinary poisoning through tetanus toxin the muscles are the seat of two distinctly different kinds of phenomena. In the first place, the involved muscles become shortened without undergoing contraction in the physiological sense. This condition may exist alone. In the resting state they show neither the electrical phenomena nor the heat production nor the muscle tone that characterizes a state of activity. They shorten only slowly and the affected extremity thus becomes stiff and gradually immobilized. If the muscles have not undergone maximal shortening, they are still capable of voluntary or reflex contraction, as in the case of normal muscles. It is only later that we see the well-known strychnine-like reflex tetanus in which the muscles are implicated in rapidly recurring, increasingly accentuated contractions. Since it is

possible to show that both the phenomena are subserved wholly by the spinal cord, it follows that there are present in the spinal cord various structures, quite distinct from the ordinary motor mechanism, which determine the state of inactive tension of the muscles, that is to say, their length while in a state of rest. These tonus-subserving structures are not excited by other poisons, like strychnine, and we have here the fundamental distinction between strychnine poisoning and poisoning by tetanus toxin. Indeed, it was only by means of the latter poison that the existence of these length-regulating tonus centers in the spinal cord was brought to light.

I have spoken hitherto of the nervous system itself, but it is true that the physiology of structures closely connected with the nervous system, as the glands, heart, blood vessels and muscles, has been materially advanced through the use made of pharmacological agents. You are all aware of the progress in our knowledge of lymph formation and the glandular function, which we owe to studies of Heidenhain; and these again were dependent in a great degree upon the help of pharmacological methods involving the application of specific chemical stimuli. I shall mention the results of some more recent investigations in this same direction, in the belief that they may be less familiar to you. Very recently Wertheimer and Lepage, in Lille, reported a series of pharmacological investigations on secretion by the pancreas, which led them to important results. It has long been known that the pancreas may be stimulated to secretion in a reflex manner and also, as Pawlow showed, through direct irritation of the vagus nerve. We know also, as a result of Starling's work, that the pancreas can be thrown into activity directly through the specific chemical stimulus furnished by the presence of secretion in the circulating blood. Now, Wertheimer and Lepage were able to show that the gland has at least two distinct mechanisms through which it is possible to excite the secretion of pancreatic fluids; first, certain structures intimately connected with the vagus nerve, which may be excited by pilocarpine, physostigmine or muscarine, or completely paralyzed by atropine; and secondly, another set of structures which are not acted upon by these poisons, being neither excited nor paralyzed by them, but which react to certain other definite chemical stimuli like secretin. Possibly the latter apparatus is part of the sympathetic nervous system; at all events the case of the submaxillary gland has been brought forward by Wertheimer and Lepage as analogous, since in this case the terminations of the chorda may be influenced by pilocarpine and atropine, whereas the sympathetic nervous mechanism remains intact. And, finally, just as the salivary secretion differs according as it arises through the stimulation of the chorda or of the sympathetic nervous system, so does the pancreatic secretion resulting from the pilocarpine differ from that which is obtained through the action of secretin. In the latter case the secretion contains entero-kinase, that is to say, is able to digest albumin without the addition of succus entericus.

In this connection it may be mentioned that the use of pilocarpine has led to a physiological understanding of an entirely different kind of secretion, namely, the liberation of a gas. It has long been known that the swimming bladder of fishes contains a gas, the presence of which can hardly be explained by a process of simple diffusion out of the tissues. This fact, which we owe to the observation of Huefner, led Dreser to investigate the process of liberation of oxygen into the swimming bladder of the pike, with a view to determining whether pilocarpine and other

glandular stimulants gave rise to an increased accumulation. And, indeed, he found that when fishes were repeatedly injected with pilocarpine, the content of the swimming bladder in oxygen gas was distinctly greater than in the case of the gas from the normal fishes, which permits the conclusion that the epithelia of the swimming bladder liberate a gas in a manner analogous to the liberation of secretions from true glands, and further that these epithelia are not penetrable in either direction like a diffusing membrane.

Another fact deserves brief notice in this relation. It is the interesting observation of Magnus that when ammonia gas is injected into the veins the alveolar epithelium of the lungs is not penetrable, since no trace of ammonia can be detected in the expired air, whereas after the inhalation of ammonia the gas penetrates readily into the blood through these same epithelial cells. This is merely one striking example of the many known cases in which animal epithelial membranes are penetrable in one direction for certain substances like water, salts or urea, while opposing strong resistance to the passage of these in the opposite direction. The mechanism of this regulatory arrangement has not yet been cleared up and further progress seems hardly possible without the aid of pharmacological methods.

To enter upon the physiology of the heart at this time would carry us too far. Pharmacological facts which have proved of importance in giving us our present knowledge are doubtless sufficiently known to you. We may say, however, that even in regard to the recent controversy over the myogenic and neurogenic theories of the cardiac motions and over the general character of the heart muscle, the systematic study of the cardiac poisons has contributed much that is important and, as Harnack has indicated, may perhaps furnish the final decision.

Permit me now to direct your attention, for a few moments, to some of the physiologico-chemical results of pharmacological investigations. It lies in the nature of things that the results should be numerous in a field that has to do solely with the chemical inter-relations between the pharmacological agent and the living organism. I shall not tire you with an enumeration of facts already well known. I shall refer only to a few of the more significant biological reactions which we owe to pharmacological investigation. The study of poisoning by acids led to the discovery of ammonia-production in the organism, and this in turn to the Schroeder experiments, which positively demonstrated the production of urea in the liver. Pharmacological methods have also contributed materially to the elucidation of numerous other important problems in metabolism. One of the most actively discussed problems has been the question whether sugar can arise from proteid, and this question has been definitely answered, as it seems to me, by the experiments of Rolly. This observer conducted experiments on animals which had been rendered glycogen-free by means of fasting and strychnine spasms. He then brought about an increased destruction of proteids by means of fever, induced through the action of bacteria and toxines and was able to demonstrate that there occurred a new production of glycogen under these circumstances in the liver and in the muscles. As the fat-reserve of the animals had already sunk to a minimum during the period of fasting, it is clear that the source of the newly formed glycogen is to be sought in the increased destruction of proteids in the organism. The same sequence of events was demonstrated by Rolly in fasting rabbits at the time of the

great destruction of proteids that immediately precedes death.

That the problem of diabetes mellitus, though still unsolved, has received light from many sides through pharmacological investigations, I need hardly state. I will merely remind you that the discovery of phlorhizin diabetes showed us a hitherto unknown capacity of the kidney to secrete sugar, that the work of Lusk and his associates led to the establishment of a definite ratio between nitrogen and dextrose excretion in diabetes, and that Blum and Herter found an adrenalin glycosuria which may perhaps throw some light on the puzzling nervous forms of diabetes.

Again, through poisoning by phosphorus and arsenic the relation of lactic and the amido-acids to the intermediary metabolism was first shown, while as regards the more intimate metabolic processes and their relation to ferment action, the toxicological experiments of Jacobi and of Wakeman have brought us important light. Through poisoning by chloral, by camphor and nitrotoluol, the discovery of glycuronic acid was made, the normal occurrence of which in the organism was only later established. Indeed, the various chemical reactions of the organism, of which we have examples in the formation of hippuric acid in the kidneys, in sulphocyanide, in methylation, in oxidation and reduction, were all of them first discovered through the action of chemical or pharmacological agents. Furthermore, as regards the location and intensity of these processes, the investigations of Ehrlich and of Herter have given us definite information. I would like to refer here to an interesting observation from Herter's studies which demonstrates with special clearness to the eye the oxygen requirements of the muscles and shows with what energy the muscles appropriate oxygen not only from oxyhemoglobin, but also from other reducible substances. Herter found that if animals receive intravenous infusions of methylene blue the pectoral muscles were soon colored deep blue, but that if during the experiment the access of oxygen was hindered by giving the animals air mixed with carbon monoxid, the blue muscles in a few seconds recovered their natural red color; they had almost momentarily reduced the methylene blue to the colorless leucobase. It is also known that through the action of hydrocyanic acid the capacity of the organs to take up oxygen from the blood is much reduced or destroyed. This process also it was possible to render easily visible by the method of methylene blue infusion. As we have seen, the pharmacological method has revealed to us a series of functional characters of the organism; but its biological significance appears to extend even further. It seems possible with such methods, if only gradually, to reach a more intimate knowledge of the chemical constitution of protoplasm, and finally, perhaps, to arrive at an insight into the chemical interpretation of its functions. If, under the influence of a pharmacological agent, we observe an immediate essential alteration in the function of a cell, we have to assume that a chemical change has occurred in its vital center—in what Ehrlich has called the 'Leistungskern,' that is, the chemical center of vital activity. On the other hand, if we have before us a gradually developing alteration, this may have been called forth in a secondary manner, through chemical changes in the reserve material or in the supporting elements of the cells, perhaps in the groups of atoms which we conceive as side-chains. Given a knowledge of the constitution and the chemical mode of action of agents operating as acute intoxicants, we should also be able to reach conclusions as to the chemistry of their point of attack, that is to say, regarding that substratum of the living sub-

stance which corresponds to the chemical constitution and action of the poison. With a similar idea in mind Oscar Loew, twenty years ago, considered himself justified in assuming the presence of an aldehyde group in the living protoplasm, basing this view on a series of merely qualitative toxic reactions like those obtainable by hydroxylamine, diamid and other substances.

An example of another pharmacological method which may, perhaps, prove of utility is the investigation of the narcotics. The quantitative comparison of the action of aliphatic narcotics (alcohol, ether, chloroform, etc.) leads to what I believe to be the unavoidable conclusion that certain fat-like substances like lecithin must be conceived as constituting integral parts of the 'Leistungskern.' It happens that one can compare with considerable exactitude in a quantitative way, the efficacy of this numerous group of bodies. This comparison has brought out the fact that the degree of activity is approximately proportional to the individual chemico-physical affinities of all these substances, that is their solution-tensions for fat-like bodies compared with their solution-tensions for watery media. From this almost rigid parallelism it follows with a high degree of probability that in the union of ether, chloroform, etc., to a fat-like substance—a lipoid—we have the origin of the narcosis of the cell; in other words, the lipoid belongs to the essential functionally active constituents of the cell. It has been urged against this conclusion that the cell lipoids occasion merely a stronger or a weaker accumulation of the narcotic which then acts on the true albuminoid life-center of the cell in proportion to the degree of this accumulation. There are, in reality, only two possibilities. First, one may assume that the narcotic operates only through its presence in lifeless lipoids whence it acts from a distance, perhaps through a sort of induction, upon the living cell-center itself, without entering into reciprocal chemical action with its center. Such a view could be neither refuted nor established. But in order to explain the above-mentioned parallelism, it would be necessary, on this supposition, to invoke the aid of the very improbable hypothesis that all the different narcotic substances, compared on an equimolecular basis, exert an equally strong induction. And this hypothesis wholly fails to allow for the different influence of special groups of atoms, as, for example, the ethyl group, the methyl group, etc. Hence it is clear that such an action at a distance must remain problematical, and furnishes us no actual explanation. On the other hand, we may make the much more likely assumption that the narcotic substance enters into a reciprocal, reversible, chemico-physical action with some constituent of the 'Leistungskern' or 'life-center,' the strength of which reaction is dependent on the intensity of this reciprocal action. Then again, the law of mass action here comes into play, that is the law of distribution. We may even leave the lipoid for the moment out of account. In this case it would have to be regarded simply as an intermediary solvent and would remain without influence upon the equilibrium established by the narcotic between the blood and lymph plasma on the one hand and the 'Leistungskern' or 'life-center' on the other. Experiment, however, showed that the affinity of the living cell substance for a narcotic, measured by the observed intensity of action, runs parallel to the experimentally observed fat affinity of the narcotic, or, in other words, that the unknown constituent of the living cell or 'Leistungskern' must itself possess certain properties of a fatty substance, or, in short, must itself be a fat-like or lipoid body. And thus we come back to the very conclusion of which I have already spoken. I have expressed

myself in somewhat greater detail than is perhaps warranted by the importance of the question. I have, however, thought such a critical discussion of the problem of some interest, as it seems of fundamental significance for the evaluation of a pharmacological analysis of this kind.

I have already said that perhaps the highest result of pharmacological investigation may prove to be the winning of an insight into the chemical nature of life processes themselves; indeed, the first important ground in this direction has already been won. You are all familiar with the important investigations of Jacques Loeb, to whom we owe a knowledge of the essential significance of the individual metallic ions, for the general life processes. But what is still more important, Loeb has succeeded in inducing very special biological reactions as the effect of chemical action. He has shown that heliotropism can be excited by definite chemical reagents such as carbon dioxide and other substances, instead of through the action of light, which is a contribution to the understanding of the mechanism of this singular reflex function. Finally, he has shown that through certain definite chemical procedures, like the action of hypertonic salt solutions, combined with ethyl acetate, the unfructified eggs of sea-urchins may be stimulated to parthenogenetic normal development, an observation which may prove of great significance for the understanding of the process of fertilization.

And with the mention of this admirable investigation, permit me to close my address of to-day.

HANS MEYER.
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THE GEOGRAPHICAL DISTRIBUTION OF THE STUDENT BODY AT A NUMBER OF AMERICAN UNIVERSITIES

THE accompanying table explains the geographical distribution of the student body of six of the leading universities of the east and of three western institutions for the academic year 1904–1905, summer session students being omitted in every instance. In the case of Harvard University the students of Radcliffe College (undergraduate women) are not included. Efforts were made to include three other prominent western universities, but it was impossible to secure the necessary figures in shape for comparison. Examining the figures by divisions, we note in the first place that the student clientele of the University of Michigan is by no means confined to the central states, for almost four hundred students at this institution hail from the North Atlantic division. The student bodies of the other western universities included in the table, Illinois and Indiana, are to all intents and purposes local in character, although the former draws some students from the south and west. Harvard has the greatest hold on the New England states, leading in all of them except Connecticut, in which state Yale naturally occupies first place. Columbia has more students from the entire North Atlantic division than any of the other institutions, leading in its own state, and strange to say, drawing more students from the state of New Jersey than Princeton does. The University of Pennsylvania, as we should expect, has the largest following in its own state, Princeton ranking second and Cornell third.

The most striking fact to be noted in the South Atlantic division is the hold that Cornell has on this section of the country. The University of Pennsylvania, chiefly by reason of its proximity to several states in this division—notably Delaware and Maryland—draws the next largest number of students, with Columbia third and Harvard fourth, all of the universities mentioned having over one hundred students from this division. Cornell leads in the District of Columbia, with Harvard a close second.

RESIDENCES OF STUDENTS. A.—THE UNITED STATES

1904–1905	Columbia	Cornell	Harvard	Illinois	Indiana	Michigan	Pennsylvania	Princeton	Yale
North Atlantic Division	**3554**	**2405**	**3235**	**36**	**6**	**394**	**2372**	**943**	**2121**
Connecticut	84	55	59	1		7	38	17	1009
Maine	20	10	120	1		8	11	4	23
Massachusetts	61	63	2126	3		17	45	23	166
New Hampshire	4	11	68	1		3	12	3	9
New Jersey	435	142	67			11	193	296	102
New York	2809	1808	512	20	2	195	122	252	580
Pennsylvania	109	296	175	8	4	140	1939	342	194
Rhode Island	13	12	84	1		2	6	2	24
Vermont	19	8	24	1		11	6	4	14
South Atlantic Division	**118**	**175**	**114**	**8**	**1**	**38**	**147**	**87**	**99**
Delaware	6	5	3				33	2	7
District of Columbia	5	49	40	2		13	23	17	25
Florida	12	3	4			4	8	3	6
Georgia	22	6	6	1		9	6	4	11
Maryland	16	52	24	2		1	39	43	14
North Carolina	20	16	7	1		1	7	3	9
South Carolina	13	8	12	2		1	4	4	12
Virginia	17	26	10			4	16	7	8
West Virginia	7	10	8		1	5	11	4	7
South Central Division	**72**	**76**	**88**	**47**	**14**	**64**	**44**	**72**	**80**
Alabama	13	15	10	1		1	11	5	9
Arkansas	8	5	7	4		5	2	1	2
Indian Territory				3		2			1
Kentucky	18	10	33	9	9	26	20	28	24
Louisiana	7	8	9	6		1	1	1	9
Mississippi	9	10	3	5	1	1	1	7	3
Oklahoma			4	3		9	1	1	1
Tennessee	5	6	11	2	4	8	1	13	19
Texas	12	22	11	14		11	7	16	12
North Central Division	**262**	**381**	**526**	**3164**	**1504**	**3155**	**139**	**209**	**506**
Illinois	25	112	115	2683	15	285	23	58	140
Indiana	31	30	38	84	1453	144	18	22	36
Iowa	18	23	47	101	4	84	9	21	32
Kansas	12	2	15	18		27	5	3	21
Michigan	24	24	29	45	1	2199	9	6	35
Minnesota	23	14	23	24	6	19	4	10	40
Missouri	25	25	44	42		43	7	29	51
Nebraska	11	8	13	11	1	14	2	3	8
North Dakota	2	3	6	6		11	1		2
Ohio	73	125	160	35	23	285	52	46	119
South Dakota	4	3	2	15		8	3	1	3
Wisconsin	14	12	34	100	1	36	6	10	19
Western Division	**111**	**76**	**126**	**41**	**2**	**134**	**22**	**41**	**78**
Arizona	3		1	1		1			
California	31	15	52	11	1	23	5	6	21
Colorado	28	22	24	7		28	4	15	26
Idaho	4	2	3	5		10			1
Montana	13	5	7	7		25		4	3
Nevada	1					1			
New Mexico	1		2	2		6			
Oregon	9	6	12	1		7	2	5	10
Utah	15	13	10	3	1	14	2	7	7
Washington	6	11	12	4		15	9	3	8
Wyoming		2	3			4		1	2
Insular and Non-Contiguous Territories	**4**	**17**	**9**	**4**	**4**	**9**	**3**	**2**	**15**
Alaska								1	
Hawaiian Islands	2	5	6	1		1			10
Philippine Islands		9	2	2	4	3	1		5
Puerto Rico	2	3	1	1		5	2	1	
Total	**4121**	**3130**	**4098**	**3300**	**1531**	**3794**	**2727**	**1354**	**2899**

RESIDENCES OF STUDENTS.—*Continued.* B.—FOREIGN COUNTRIES

1904–1905	Columbia	Cornell	Harvard	Illinois	Indiana	Michigan	Pennsylvania	Princeton	Yale
North America	**51**	**38**	**43**	**9**		**23**	**41**	**8**	**31**
Canada	30	21	34	5		14	21	6	30
Central America	3	2					6		
Cuba	8	8	3			1	5	1	1
Mexico	8	7	3	4		8	3	1	
West Indies	2		3				6		
South America	**4**	**18**	**1**			**2**	**11**	**1**	**2**
Argentine Republic		9				1			1
Brazil	1	5	1				4		1
Chili	2						5		
Colombia						1		1	
Ecuador		1							
Paraguay							1		
Peru	1	3					1		
Europe	**26**	**21**	**25**	**3**	**1**	**5**	**28**	**5**	**11**
Austro-Hungary	1	1					2		
Belgium							1		
Bulgaria		1	1			1			
France	1	1	5				3		2
Germany	4	1	3			1	5		
Greece									1
Great Britain and Ireland	10	6	9			1	4	4	2
Holland	1	2	1			1	1	1	
Italy	3		1				1		
Norway		1		2					
Portugal				1					
Roumania		1							
Russia	3	2					5		
Spain	2		1				1		
Sweden	1	2					1		
Switzerland							4		
Turkey		3	4		1	1			6
Asia	**29**	**14**	**15**	**4**	**6**	**8**	**9**	**6**	**34**
Asia Minor	2						1		8
China	6	6	1					1	6
India	2	2	1		1	2	1		1
Japan	19	6	13	3	5	6	7	5	19
Persia				1					
Africa	**4**	**2**	**2**				**1**		**2**
Cape of Good Hope	2								1
Mauritius									1
Morocco			1						
Natal	1								
Transvaal	1	2	1				1		
Australasia	**3**	**7**	**8**	**2**			**36**		**3**
Australia	3	6	5	1			23		2
New Zealand		1	3	1			13		1
Total	**117**	**100**	**94**	**18**	**7**	**38**	**126**	**20**	**83**
Grand Tota	**4238**	**3230**	**4192**	**3318**	**1538**	**3832**	**2853**	**1374**	**2982**

Columbia has the largest following in the states of Florida, Georgia, North Carolina and South Carolina, many of these students being registered in the graduate faculties and in Teachers College. Cornell leads in Maryland and Virginia, with Princeton second in the former state and Columbia in the latter. Illinois and Indiana have no representation to speak of in this section of the country.

In the south central division Harvard leads with 88, Yale is second with 80, and Cornell third with 76, Columbia and Princeton following close behind with 72 each. Cornell leads in Alabama and Mississippi, with Columbia second in each. In

Arkansas Columbia leads, with Harvard second; Harvard and Yale have the largest number from Louisiana; Harvard leads in Kentucky, Yale in Tennessee and Cornell in Texas, with Princeton second in each. The largest Oklahoma delegation is found at Michigan. The large number of students from the state of Kentucky is worthy of mention.

The universities of the middle west are naturally far in the lead in the north central division, Illinois ranking first, although Michigan is not far behind. Of the eastern universities Harvard stands first in this division, with Yale second, Cornell third and Columbia fourth. The University of Indiana has few followers outside of its own state, whereas the Universities of Illinois and Michigan are well represented in all of the states of the division. Of the eastern universities Yale leads in Illinois, with Harvard second, Cornell also having over one hundred students from this state, many of whom hail from the city of Chicago, which, like the city of Washington, is a Cornell stronghold. In Indiana and Iowa Harvard leads the eastern universities, with Yale second, Columbia being third in the former and Cornell in the latter state. In Kansas, Michigan, Minnesota and Missouri Yale leads Harvard, Columbia being third in Kansas, tying with Cornell for third place in Michigan and Missouri, and with Harvard for second place in Minnesota. Harvard has the largest following of the eastern universities in Nebraska, North Dakota, Ohio and Wisconsin, Columbia leading in South Dakota. All of the eastern universities attract more students from Ohio than Illinois or Indiana, although Michigan has by far the largest student body from that state, Harvard, Cornell and Yale also being well represented.

In the western division Michigan leads, with Harvard second and Columbia third, all of these institutions drawing over one hundred students from this section, many of whom are enrolled in the scientific schools, at least as far as Michigan and Columbia are concerned. Columbia leads in Arizona, Colorado (with Michigan) and Utah, Harvard in California and Oregon, Michigan in Idaho, Montana, New Mexico, Washington and Wyoming. California and Colorado send by far the largest delegations to the universities included in the table, the representation of Arizona, New Mexico, Nevada and Wyoming at the eastern universities being insignificant.

The insular territories are just beginning to send students to the American universities and their representation will no doubt increase rapidly in the immediate future. Cornell leads all the other universities enumerated in the number of students from these territories. There is only one student from Alaska at any of the institutions in the list, namely, at Princeton. Yale leads in the Hawaiian Islands, Cornell in the Philippine Islands, and Michigan in Puerto Rico.

As for the representation from foreign countries, the University of Pennsylvania is in the lead, with Columbia second and Cornell third, the great majority of Pennsylvania's foreign students being registered in the dental school of that institution. It is worthy of note that there are over six hundred students from foreign countries enrolled at the nine universities included in the table, which is, indeed, a remarkable showing, and it is safe to predict that this number will show a constant increase in the coming years. No less than 125 of these foreign students hail from Europe. In North America Columbia leads, with Harvard second and Pennsylvania third; Cornell has the largest following in South America, with Pennsylvania second and Columbia third; in Europe Pennsylvania leads, with Columbia second and Harvard

third; Yale leads in Asia, with Columbia and Harvard following in the order named; Columbia leads in Africa and Pennsylvania in Australasia. Of the European countries Great Britain furnishes the largest delegation, while the largest number of Asiatic students hail from Japan.

Much has been said and written lately about the decrease in the number of western students in attendance at eastern institutions, but the accompanying figures show that all of the eastern universities enumerated still have a considerable following in the west and south. It is a following that is, in most cases, actually increasing each year, although, of course, not at the same rapid rate at which most of the western universities are growing in number of students. The accuracy of the figures is somewhat marred by the fact that a tendency exists on the part of students who are not residents of the place in which their university is located, to register this place as their permanent residence. This tendency is encountered especially at institutions located in large cities, but the general results are not affected thereby.

The table illustrates in striking manner the truly national character of the leading eastern universities and of several of the western institutions, and it is to be hoped that they will retain this characteristic in the coming years, since it is undeniably an important factor in the ever spreading unification of the various sections of the country. RUDOLF TOMBO, JR.

COLUMBIA UNIVERSITY.

SCIENTIFIC BOOKS.

Traité de Biologie. Par FÉLIX LE DANTEC, chargé du cours d'Embryologie générale à la Sorbonne. Paris, Alcan. 1903. Pp. 553.

This book, which is the condensation and completion of the numerous studies in biological theory (and in several other subjects) that have come from the productive pen of M. Le Dantec during the past ten years, is one of the most ambitious and elaborate of the recent attempts to synthetize the general results of biological research. As such, it will be of interest to both the philosopher and the naturalist. M. Le Dantec covers the whole ground and something more, adding a lengthy appendix in which the 'biological foundations' of psychology and sociology are set forth. The psychological chapter is chiefly remarkable for the author's entire innocence of any suspicion that mental phenomena have any peculiarities or complexities of their own. Thus, consciousness is once for all disposed of by this definition: 'Consciousness is the property which our body has of being informed at each moment of its structure at that moment' (*la propriété d'être au courant de sa structure actuelle*); the obvious objection that this definition takes no account of the facts that we know very little of our structure and that consciousness chiefly is representative of 'objects,' is summarily met, *en passant,* by observing that 'this property suffices to bring it about that we are secondarily aware of what goes on about us, as a result of the effect upon our structure of those external events that make an impression upon our sense-organs.' Here all that requires explanation, and correlation with physiological phenomena, is cheerfully taken for granted at the start. This 'property' which is consciousness, moreover, is not confined to our bodies, but—though never aught but an epiphenomenon, functionless in evolution—extends down to the simplest material structure; the argument to which the grounds for the mind-stuff theory reduce themselves, for M. Le Dantec, may be commended to the logician as a classic example of the fallacy of division: "Since our consciousness is so intimately connected with our structure, and since we are formed of chemical substances—carbon, hydrogen, *etc.*—we ought to conclude that these chemical substances contain in themselves the elements of our consciousness, and that, just as our body is built up of atoms, our consciousness is built up out of the elements of consciousness connected with each atom." It is really depressing to find men learned in one science still reasoning like babes and sucklings in another —and convinced, withal, that they alone know

anything about the matter. The sociological chapter is inconclusive; nothing very specific seems to be built upon the 'biological foundations,' in this case, except the doctrine—which one had supposed extinct these many years—that we should bring up our children by 'teaching them exclusively truths that are beyond dispute, such as those of mathematics, geography, anatomy.'

When, however, he sticks to his last, M. Le Dantec has much that is not only significant, but also closely reasoned, to say, and the book can not be neglected by any who are interested in the larger problems of general biology. The work is characterized by an unusually careful attention to the question of biological method—to the determination of the nature and limits of 'explanation' in this science—and should be of use in increasing, so to say, the methodological self-consciousness of naturalists. No one, doubtless, was ever more resolute than M. Le Dantec to banish confusion and equivocation from biological language, to define at the outset the peculiar 'biologist's fallacies' and, above all, to avoid the naturalist's besetting temptation, the use—especially in dealing with such processes as cell-division and maturation—of vaguely teleological phraseology. As the chief sinner in this and other matters of method, Weismann is pursued throughout the book with somewhat excessive ferocity; 'the meeting-place of all the errors possible in biology,' is one of the characterizations of Weismann's system. The main purpose of the book, however, is 'to describe the known part of the phenomena of life in physico-chemical terms,' and to 'show that life is no more essentially different from other natural phenomena than are the properties of benzine essentially different from those of alcohol.' This, however, does not mean that the author proposes to bring vital phenomena under the already known laws of chemistry or physics. He regards the power of assimilation as the primary and only essential characteristic of living matter; and assimilation, though a chemical reaction, is, upon the author's own showing, an entirely unique and even somewhat paradoxical chemical reaction. Beginning with a proposed formulation of the nature of this primary process, M. Le Dantec attempts to correlate with this in a connected manner—and in that sense, to explain—the laws of the other vital phenomena, offering, by the way, many observations that are of value apart from their connection with the main argument. The book, which is copiously illustrated with good diagrams, makes abundant use of recent biological investigations, and is full of ingenious hypotheses that are illuminating and suggestive, even where the reader feels that the author has not constantly discriminated between 'possible hypothesis' and 'only possible hypothesis.' To go into full details of the discussion lies neither within the competency of the present reviewer nor within the limits of reasonable length.

ARTHUR O. LOVEJOY.

SCIENTIFIC JOURNALS AND ARTICLES.

THE first article in the August number of the *American Geologist* is a biographical sketch with portrait of Professor Albert A. Wright by Professor George F. Wright. Professor W. O. Crosby contributes the second installment of his article on the 'Genetic and Structural Relations of the Igneous Rocks of the Lower Neponset Valley, Massachusetts.' The longest paper and the one of greatest general geological interest is by Drs. J. W. Beede and E. H. Sellards on the 'Stratigraphy of the Eastern Outcrop of the Kansas Permian.' The writers accept the Wreford limestone as the base of the Kansas Permian and they have traced and mapped this limestone from southern Nebraska nearly across Kansas. Its outcrop is shown on a map, while another plate gives a characteristic view of the 'Flint Hills Escarpment' in Kansas, which is composed in part of lower Permian formations. In conclusion the writers state 'that the strata of the lower Permian are remarkably persistent and uniform when the great extent of outcrop is considered.' President Charles R. Keyes contributes a paper on 'The Fundamental Complex beyond the Southern End of the Rocky Mountains.'

The October number of *The American Journal of Science* contains the following articles:

B. B. Boltwood: 'Ultimate Disintegration Products of the Radioactive Elements.'

C. P. Flora: 'Use of the Rotating Cathode for the Estimation of Cadmium taken as the Sulphate.'

A. J. Moses: 'Crystallization of Luzonite and other Crystallographic Studies.'

F. E. Wright: 'Determining of the Optical Character of Birefracting Minerals.'

C. Barus: 'Groups of Efficient Nuclei in Dust-Free Air.'

T. Holm: 'Studies in the Cyperaceæ.'

P. F. Schneider: 'Preliminary Note on Some Overthrust Faults in Central New York.'

F. N. Guild: 'Petrography of the Tucson Mountains, Pima Co., Arizona.'

The American Chemical Journal for October contains articles, as follows:

C. Loring Jackson and Latham Clarke: 'Bromine Addition-Compounds of Dimethylaniline' (Contributions from the Chemical Laboratory of Harvard College).

Harry C. Jones and H. P. Bassett: 'The Approximate Composition of the Hydrates Formed by a Number of Electrolytes in Aqueous Solutions, Together with a Brief General Discussion of the Results Thus Far Obtained.'

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

The twelfth summer meeting of the American Mathematical Society was held at Williams College, Williamstown, Mass., on Thursday and Friday, September 7–8. Twenty-eight members were in attendance. Two sessions were held on Thursday, and a third on Friday morning. Professors Morley and Ferry filled the chair. The council announced the election of the following persons to membership in the society: Lieutenant-Colonel C. P. Echols, U. S. Military Academy; Professor G. B. Guccia, University of Palermo; Professor H. B. Evans, University of Pennsylvania; Dr. A. M. Hiltebeitel, Princeton University; Dr. J. M. Poor, Dartmouth College; Professor J. E. Williams, Virginia Polytechnic Institute. Eight applications for membership were received. The total membership of the society is now nearly five hundred.

At the close of the Thursday morning session the members were conducted through the grounds and buildings of Williams College and the collection of mathematical models were shown. On Friday afternoon the members assembled at the house of President Hopkins and through the courtesy of the college were taken in carriages on an excursion over the Berlin Mountain, whose less accessible regions were traversed on foot. Several foot tours were also made on Saturday. The hospitality of the college authorities was appropriately recognized by appreciative resolutions at the close of the meeting.

The following papers were read at the meeting:

W. H. Bussey: 'Galois field tables for $p^n \leqq 169$.'

Edward Kasner: 'A geometric property of the trajectories of dynamics.'

G. A. Bliss: 'A generalization of the notion of angle.'

W. B. Fite: 'Irreducible linear homogeneous groups.'

Saul Epsteen: 'Note on the structure of hypercomplex number systems.'

Maurice Fréchet: 'Sur l'écart de deux courbes et sur les courbes limit.'

Richard Morris: 'On the expressibility of the automorphic functions of the group $(0, 3, l_1, l_2, l_3)$ in terms of theta series.'

J. I. Hutchinson: 'On certain hyperabelian functions which are expressible by theta series.'

N. J. Lennes: 'Concerning real functions of one real variable which are completely determined over an interval by the values of the function and its derivatives for one value of the independent variable.'

W. A. Manning: 'On the arithmetic nature of the coefficients in groups of finite monomial linear substitutions.'

Max Mason: 'On the boundary value problems of linear ordinary differential equations of the second order.'

G. A. Miller: 'On the possible number of operators of order 2 in a group of order 2 .'

Frank Morley: 'On two cubic curves in triangular relation.'

C. H. Sisam: 'On the determination of the nodal curve on a ruled surface.'

A. S. Chessin: 'On the strains and stresses in a rapidly revolving circular disc.'

L. E. DICKSON: 'On the quaternary linear homogeneous groups modulo p of order a multiple of p.'

L. E. DICKSON: 'On finite algebras.'

VIRGIL SNYDER: 'On a type of rational twisted curves.'

E. J. TOWNSEND: 'Arzelà's condition for the continuity of a function defined by a series of continuous functions.'

H. S. WHITE: 'Rational plane curves as related to Riemann transformations.'

F. R. MOULTON: 'A class of periodic solutions of the problem of three bodies.'

C. N. HASKINS: 'Note on the differential invariants of a surface and of space.'

E. V. HUNTINGTON: 'The continuum as a type or order: an exposition of the modern theory.'

The next meeting of the society will be held at Columbia University, on Saturday, October 29. The San Francisco section meets at the University of California, on September 30. The annual meeting of the society for the election of officers will be held on Thursday and Friday, December 28–29.

F. N. COLE,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE PROBABLE ORIGIN OF CERTAIN BIRDS.

IN a recent article in SCIENCE,[1] Mr. W. E. D. Scott attempts to apply the 'mutation' theory of de Vries to the origin of certain puzzling forms of North American birds, his conclusion being:

> In the light of the evidence set forth [in the preceding pages of his article] only one answer can be made to the question as to the part the process defined by de Vries as 'mutation' is playing among higher animals to-day. Beyond doubt we have witnessed the birth of new species of birds during the past seventy years. Moreover, some of these new species have flourished so as to have become a salient part of the bird fauna in the region where they occur and where they were unknown to skilled ornithologists, who carefully studied these regions in the early part of the last century.

The birds here considered by Mr. Scott are nine in number, all from the 'Hypothetical List' of the American Ornithologists' Union Check-List of North American Birds, and, in the order of discovery, are as follows: Small-headed warbler (*Muscicapa minuta* Wilson, 1812), Blue Mountain warbler (*Sylvia montana* Wilson, 1812), carbonated warbler (*Sylvia carbonata* Audubon, 1831), Cuvier's kinglet (*Regulus cuvierii* Audubon, 1832), Townsend's bunting (*Emberiza townsendii* Audubon, 1834), Cooper's sandpiper (*Tringa cooperi* Baird, 1858), Brewster's linnet (*Acanthis brewsterii* Ridgway, 1872), Lawrence's warbler (*Helminthophaga lawrencei* Herrick, 1874), Brewster's warbler (*Helminthophaga leucobronchialis* Brewster, 1876). The first four of these birds are known only from the descriptions and figures given of them by Wilson and Audubon; of each of the next three, the original and still unique type specimen is preserved. The remaining two, both forms of *Helminthophila*, are known from numerous examples, they being of more or less frequent occurrence (if we reckon the variants of each) over a limited area in southern New England (mainly the lower Connecticut Valley), the lower Hudson Valley and northern New Jersey.

Mr. Scott comments on the first seven very briefly, but states, in concluding the enumeration, that he is compelled 'to consider these forms as mutations (which were not perpetuated) from species still existing.' About seven pages are then devoted to the remaining two forms, *Helminthophila leucobronchialis* and *H. lawrencei*, in which he gives a partial list of the known captures of each, mostly in footnotes in small type, with more or less extended extracts from the records relating to them, and often a summary of the opinions that have been expressed regarding the status and relationships of the two forms. The number of specimens of *H. leucobronchialis* at present extant is estimated to be 'at least 150,' and of *H. lawrencei* 'between 20 and 25.'

These two forms are discussed separately, at some length. Under *H. leucobronchialis* (*l. c.*, p. 278), he expresses his conclusions respecting them as follows:

[1] 'On the Probable Origin of Certain Birds,' by William E. D. Scott, SCIENCE, N. S., Vol. XXII., No. 557, Sept. 1, 1905, pp. 271–282.

In view of the foregoing facts, I am of the opinion that in *H. lecubronchialis* and in *H. lawrencei*, . . . we have examples of two separate and distinct 'mutations' from a common parent stock or species. That is, I believe that *H. pinus*, early in the last century became unstable as a species and began to throw off what must be considered as 'mutants,' taking de Vries's definition of the word. In other words, *H. pinus* is alone responsible and is the direct ancestor of both *H. leucobronchialis* and *H. lawrencei;* that these 'mutants' have up to the present time generally bred back into the parent stock, and that in so doing the instability of *H. pinus* has increased geometrically with the constant result of the increasing number of both kinds of 'mutants.'

While the 'mutation' theory may be a good hypothesis to consider in respect to these peculiarly unstable groups of birds, it must be noted that the method of their origin and the results, as now known, are very unlike the methods and results of mutation in plants, as made known by de Vries. The facts and conditions are not to any great extent parallel. Instead of the resulting 'mutants' remaining constant and breeding true, as in the case of primroses, they are in this case unstable and are believed[2] to interbreed freely with each other and the parent stock. Besides, in building up his theory of 'mutants' in the case of these warblers, we think Mr. Scott has belittled the evidence of hybridity and laid too much stress upon the (assumed) completeness of knowledge 'in the early part of the last century' of the ornithology of the area now inhabited by these birds. While it is true that most of these puzzling birds have been taken within the last twenty or twenty-five years, it does not follow that, as Mr. Scott says:

It is not likely that a form or kind of bird so common as *H. leucobronchialis* is at the present time, and ranging over as large an area as from Pennsylvania to Massachusetts and from Virginia to Michigan, should remain unknown to the earlier ornithologists, such keen field naturalists as Audubon and Wilson, Baird, Lawrence, Coues and Prentiss. Nuttall made careful and prolonged study of birds in the region where Mr. Brewster collected the type. Yet none of these close observers and good collectors either recorded or secured an individual of this kind. Clearly then, the presumption is that this bird could not have been so common early in the last century as it is now, if indeed it existed at all at that time.

First as to the range of these two forms, with reference to that given in the above quotation. *H. lawrencei* has been found only in the northern part of New Jersey, the lower Hudson Valley, and the lower Connecticut Valley. *H. leucobronchialis* has but five records (all of migrants) south of northern New Jersey, two of which are for southeastern Pennsylvania, two for the immediate vicinity of Washington, where collectors abound, and the other (not mentioned by Scott) for Louisiana. The bird has been reported as observed in northern Ohio, but the only record of a captured specimen for the region west of New Jersey and eastern New York is a single bird taken in southern Michigan. There are also only two records for the region north of Connecticut, which include the original type specimen (Newtonville, Mass., 1870) and one other (Hudson, Mass., 1858). Thus the known distribution of these forms, at least for the breeding season, is narrowed down to practically northern New Jersey, the southeast corner of New York (extreme lower Hudson Valley) and Connecticut. This is quite different from the distribution conditions that might be implied from the sweeping statement above quoted from Mr. Scott.

Now as to the work of the earlier naturalists. Both Wilson and Audubon explored the region around Philadelphia, where, notwithstanding all the careful field work of many expert collectors during recent years, there are only two records for *leucobronchialis* and none for *lawrencei.* These naturalists also each made journeys to New England, but their visits were brief and for the most part with other interests than field work, and it is well-

[2] By those who are most familiar with the facts. Interbreeding is known to occur between the two stock species, and also between their offspring and both of the stock species, and it has been repeatedly assumed by the best authorities that the hybrids are fertile *inter se.* This feature of the case is of course impossible of demonstration, owing to the nature of the conditions—the impossibility of continued observation of the same individuals for a series of years.

known that neither was accustomed to preserve, or even to collect, many specimens. Lawrence lived in New York City, and doubtless made frequent excursions into the adjoining country, but business exactions permitted little real field work comparable to that of present-day collectors and observers. In fact, his collection shows that he collected very few birds himself, but acquired them by purchase. Nuttall was a botanist and, although intensely interested in birds, if he ever collected many birds in the vicinity of his Cambridge home, the fact remains unrecorded. That his field work there in ornithology is to be compared with that of any one of the many enthusiastic collectors that have gleaned the region year after year for the last three decades is not to be even suggested. In any case, he worked, as already shown, practically outside of the range of these forms, since only two specimens have yet been obtained from eastern Massachusetts. Coues and Prentiss did their field work hundreds of miles distant from the principal range of these forms, and their collecting was casual and intermittent, in comparison with that of the numerous recent collectors in the Washington vicinage. Baird's field work, restricted to his early days, was also outside of the region here in question. Finally, the rapid increase in the number of these curious birds taken or observed during the last ten or fifteen years certainly has not more than kept pace with the greatly increased number of collectors of an expert class unknown 'in the early part of the last century.' There are now, within the area favored by these interesting birds, hundreds of private collections, each numbering more specimens of birds, nests and eggs, than all that had been collected in New England, New York and New Jersey prior to the middle of the last century. While there are now hundreds of persistent collectors within this prescribed area, one could probably count on the fingers of the two hands all those who have taken or observed in life any representatives of the two birds here in question. If Mr. Scott, who has done an exceptionally large amount of collecting in New Jersey and New England, has ever taken a specimen of either of these forms he seems to have neglected to record the fact of such an interesting capture. Evidently, then, the facts in the case fail to support the supposed rapid increase in the numbers of the birds in question alleged by our author to be so evident.

The ornithologists who are most familiar with these birds, through the examination of specimens and in life, have proposed or supported the theory of hybridity between *H. chrysoptera* and *H. pinus* as accounting in a fairly satisfactory manner for the birds, with their endless variants, known as *H. leucobronchialis* and *H. lawrencei*. But this does not seem to satisfy Mr. Scott, who says: "Nor does it seem that the theory of hybridity is supported when we consider the vast number of known specimens already in collections and the fact that it is possible to observe living specimens . . . each year." He further says: ". . . for, though hybrids do occur among wild birds, they can be considered at best as only casual, and the infertility of hybrids, especially among the higher animals, is too well known to need further comment here"! The case of *Colaptes cafer* and *C. auratus* must have, at this moment, escaped Mr. Scott's recollection, between which two species, for a thousand miles, north and south, along the line where their ranges meet, hybrids of all degrees, with every possible combination of the characters of these two strikingly different looking species are found almost to the exclusion of birds of pure blood of either species. The area of hybridity in this case occupies a belt hundreds of miles in width, the prevalence of birds presenting more or less traces of mixed blood gradually fading out both to the eastward and to the westward.

Mr. Scott makes only passing allusion to Dr. Bishop's important paper on this subject in a recent number of *The Auk* (XXII., January, 1905, pp. 21–24), and none to his conclusions, which are that *H. leucobronchialis* 'is merely a leuchroic phase of *H. pinus*, which, from its appearing frequently only within a very limited area, may in time become a species; and that *H. lawrencei* is a hybrid between *H. chrysoptera* and *H. pinus*.'

Near the end of Mr. Scott's paper, he quotes at considerable length from a paper recently

published in *The Ibis* (1903, pp. 11–18, pl. I.), by Professor H. H. Giglioli, entitled 'The Strange Case of *Athene chiaradiæ*,' a curious variant of *A. noctua,* having black instead of yellow irides, and some variations in the markings of the plumage from the normal form. The facts, and the speculations thereon by Professor Giglioli, are of much interest, and Mr. Scott thinks they help to confirm his view of the case of the two forms of *Helminthophila.* But the facts are not at all parallel, the nine specimens of the abnormal owl being traced back to, presumably, a single pair. This case has the essential features of a 'mutant,' as these peculiar owls were not the product of the union of two species, and hence not 'hybrids.' In other words, it is what Giglioli appropriately terms 'a case of *neogenesis*,' which might, should the progeny survive, constitute a new species. A further history of this case will naturally be awaited with great interest.

As already shown, I fail to see any good basis for Mr. Scott's attempt to employ the 'mutation' theory in explanation of the case of *H. lawrencei* and *H. leucobronchialis,* and believe still that these unstable and ever-varying forms are primarily the result of hybridity between *H. chrysoptera* and *H. pinus,* with which belief the known facts in the case are wholly consistent. Dichromatism may play a part, as several previous writers have suggested. The two forms are known to interbreed with each other and also with the parent stock, producing fertile offspring. They thus far, also, have been found (with the exception of a few migrating birds) only in the area where the breeding ranges of *H. chrysoptera* and *H. pinus* overlap. That they have not been found throughout this overlapping area is more than likely due to the absence from it of a sufficient number of expert observers. No section of the country within this range has a tithe of the expert field observers and collectors, proportionately to the area, that have been working for years throughout the limited district which has thus far almost exclusively produced the known examples of these birds. There seems to be no obvious reason why they should not occur sparingly westward over a narrow belt south of the Great Lakes to Wisconsin, where thus far they seem to have been almost wholly overlooked.

In taking up this subject, Mr. Scott appears to have proceeded without a very clear conception of either the essential facts of the warbler case or of the phenomena of 'mutants.' His assumption of the recent rapid increase of these forms rests on statements that are both misleading and irrelevant. The region of their occurrence is wholly outside of the fields of research of the ornithologists he mentions as evidence of the thorough knowledge of the ornithology of this region he assumes to have existed 'in the early part of the last century,' while, as regards numbers and methods, these early workers are not for a moment to be compared with those of the last few decades. Besides, it is only a few experts, who have made these birds a specialty, and know their haunts and notes, who have any success in their discovery. The facts, as already said, of the known relationships and the instability of these forms, harmonize poorly with the phenomena of mutations, shown by de Vries in relation to plants, in which the new forms arise with definite and stable characters, which they can transmit without modification to an apparently endless succession of generations. J. A. Allen.

SPECIAL ARTICLES.

BATTERY RESISTANCE BY MANCE'S METHOD.

Among the many methods for measuring battery resistance, one of the oldest, and apparently least understood, is that known as 'Mance's method.' As usually discussed in text-books this method is described as being a modification of Wheatstone's bridge, in which the cell to be measured takes the place of the unknown arm and the usual battery is replaced by a simple key. When opening or closing this key produces no change in the steady deflection of the galvanometer the bridge is balanced and, 'therefore, the usual relation of Wheatstone's bridge is satisfied.' It is the object of this paper to show wherein many writers have erred in this explanation,

and to indicate a direct and simple derivation of the desired relationship.

Wheatstone's bridge consists, essentially, of two circuits in parallel through which an electric current can flow. Let these circuits be represented by *ABD* and *ACD*, Fig. 1, and

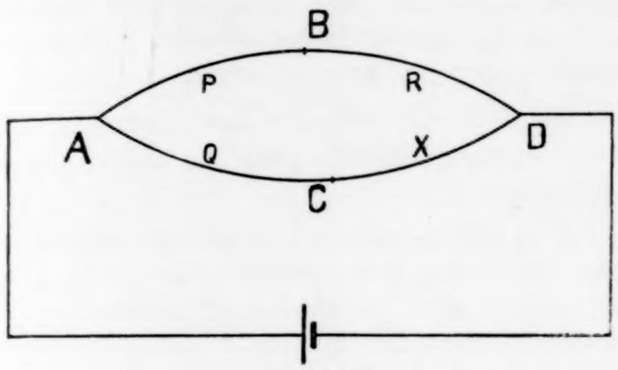

FIG. 1.

let the currents through the two branches be denoted by I and I'. Since the fall of potential from A to D is the same whichever path is considered, there must be a point C on one circuit, which has the same potential as any chosen point B of the other. If one terminal of a galvanometer is joined to B and the other terminal is moved along ACD the galvanometer will indicate zero deflection when the point C has been found. Since B and C have the same potential, the fall of potential from A to B is the same as from A to C, or in terms of the currents and the resistances,

$$IP = I'Q$$

where P and Q are the resistances of AB and AC, respectively.

Similarly for the other part of the circuits

$$IR = I'X.$$

Dividing one equation by the other gives

$$P : Q :: R : X$$

as the relationship of the resistances when the bridge is balanced. In the usual method of using the Wheatstone bridge three of these resistances are known and the value of the fourth is easily computed from the above relation as soon as a balance is obtained.

In teaching 'Mance's method' the attempt has been made to deduce directly the expression for the resistance of the cell similarly to the above deduction for the Wheatstone bridge. Some three years ago a careful search of the literature was made, with the result that no direct and simple explanation of the method could be found, while the best authorities, German, English and American, either made statements which are absolutely false or passed over the subject in silence.

The first edition of Maxwell, published a few months after Mance's original paper, gives the method as follows (the italics are my own):

The measurement of the resistance of a battery when in action is of a much higher order of difficulty, since the resistance of the battery is found to change considerably for some time after the strength of the current through it is changed. In many of the methods commonly used to measure the resistance of a battery such alterations of the strength of the current through it occur in the course of the operations, and therefore the results are rendered doubtful.

In Mance's method, *which is free from this objection*, the battery is placed in *CD* and the galvanometer in *BC*. The connexion between *A* and *D* is then alternately made and broken. If the deflexion of the galvanometer remains unaltered

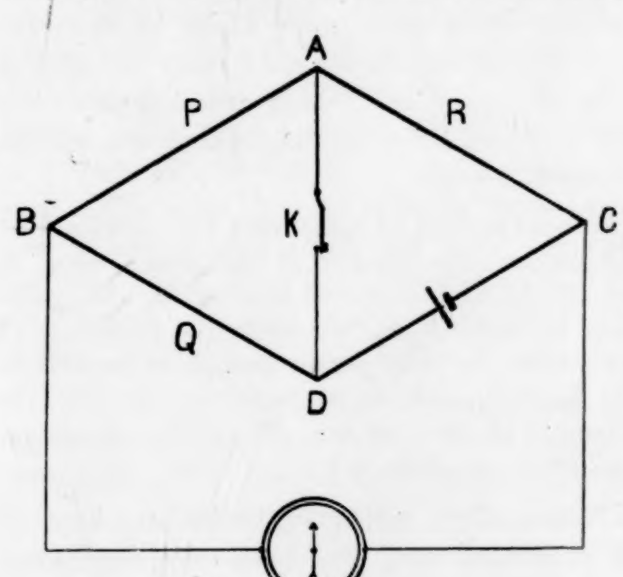

FIG. 2.

we know that *AD* is conjugate to *BC*, whence, $QR = PX$, and X, the resistance of the battery, is obtained in terms of known resistances P, Q, R. * * * In this method of measuring the resistance of the battery *the current in the battery is not in any way interfered with during the opera-*

tion, so that we may ascertain its resistance for any given strength of current, so as to determine how the strength of current affects the resistance.

A glance at Fig. 2 will show that in Mance's method the battery is joined in series with P, Q and R, and no two points having the same potential can be found on this circuit. The effect of closing K is to short-circuit P and Q, thus closing the battery through R alone, which frequently is not very large. Often the current from the cell is changed from a few ten-thousandths of an ampère to several tenths, *and this larger current flows through the key from A to D*. Thus it is readily seen that the points A and D are *not* at the same potential, and that the current in the cell is subject to considerable variation.

Lodge[1] pointed out this error in Maxwell and gives a very clear exposition of the method, but does not deduce any formula, concluding with the words:

I have entered into this matter at some length because the slip in Maxwell is getting repeated in other books, and it is well to get clear on the subject.

Had all later writers read this admirable account the present paper would be unnecessary. But even after this clear exposition Maxwell has gone through two editions with the only result that the last paragraph quoted above now reads:

In this method of measuring the resistance of the battery, the current in the galvanometer is not in any way interfered with during the operation, so that we may ascertain the resistance of the battery for any given strength of current in the galvanometer so as to determine how the strength of the current affects the resistance. [Which is meaningless.]

However, the makers of books have kept on as though nothing had been said, and some have fallen into a more grievous error in the attempt to deduce a formula for this method from its analogy with Wheatstone's bridge.

A standard English work written in 1887 says:

In the Wheatstone bridge diagram, if the battery be placed in the X arm so as always to send a current through the galvanometer, then, by the principle of the bridge which we have already explained, when $P:Q=R:X$, the opening or closing of the key can have no influence on the current in the galvanometer, *inasmuch as the two points A and D are at the same potential.* This is the principle of Mance's method, in which adjustments are made of P, Q and R until the current in the galvanometer remains the same, whether the key is open or closed.

[1] O. J. Lodge, *Phil. Mag.*, 1877, Vol. 3, p. 515.

One of the largest and best German treatises, written in 1893, puts the matter more explicitly.

But as no current can flow through the bridge (AD, containing the key) the potential at A is the same as at D, and the fall of potential over P is equal to that over Q and the fall of potential over R is equal to that over X. So then if there is no current through the bridge the same current, i, flows through the entire circuit BAC, and the current i' flows through the entire circuit BDC, and

$$iP=i'Q, \quad iR=i'X, \quad P:Q=R:X,$$

from which the desired resistance is obtained.

Of still more recent date are two American manuals, excellent in many respects, which follow the example set by the older books. One of these, written in 1898, puts the matter thus:

If the cell, X, is placed in the branch CD of the bridge, and a key, K, inserted in place of the battery in the branch AD, there will, of course, always be a current through the galvanometer, and its needle will be deflected. But if, on making and breaking the key K, there is no change in this deflection, *A and D must have the same potential;* otherwise some of the current would have gone through AD when the key was closed and so a different quantity would have gone through the galvanometer. If, however, A and D have the same potential,

$$P:Q::R:X.$$

* * * Under this condition no current flows through the branch containing the key K.

The other book, written only last year, is simply another echo.

The adjustment consists in finding such a point of contact, A, that opening and closing the bridge does not alter the galvanometer reading. Then *A and D are at the same potential*, and the re-

sistances are in the following proportion.

$$P:Q::R:X.$$

It will now be of interest to turn to the original paper by Mance.[2] This was communicated to the Royal Society of London in 1871 by Sir Wm. Thomson. Mr. Henry Mance was superintendent of the Mekran Coast and Persian Gulf Telegraph Department and was especially interested in telegraph lines and cables and the detection of faults. He considers such a line, well grounded at each end and containing a battery and a galvanometer shunted by a circuit AB. The current through the galvanometer

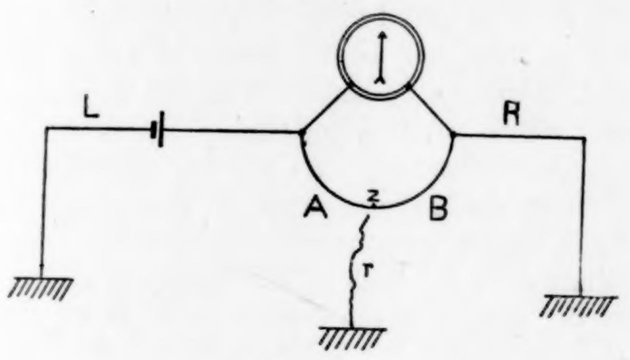

FIG. 3.

can be readily computed. But now let a leakage be applied to a point on the shunt. In general the deflection of the galvanometer will be changed, but by moving the leakage along AB a point can be found for which the galvanometer gives the original deflection. And this deflection will remain the same for all values of the leakage from 'dead earth' to infinity.

Presuming the electromotive E in L to remain constant, and taking $r=0$, we have the intensity of the current passing through G represented by the equation

$$\frac{E}{\left\{L+\frac{G(A+B)}{G+(A+B)}+R\right\}\left\{\frac{G+(A+B)}{A+B}\right\}}$$

but after r is connected, the equation becomes

$$\frac{E}{\left\{L+\frac{\left(G+\frac{RB}{R+B}\right)A}{A+G+\frac{RB}{R+B}}\right\}\frac{G+\frac{RB}{R+B}+A}{A}}$$

[2] Henry Mance, *Proc. Roy. Soc. Lond.*, 1870, Vol. 19, p. 248.

As the condition that the galvanometer deflection remains unchanged, the first of these equations must be equal to the second, from which we obtain the formula

$$L=R\frac{A}{B},$$

the resistance G being immaterial. It will, therefore, be seen that R always bears the same proportion to L that B does to A, the latter bearing some analogy to the proportion coils of a Wheatstone testing bridge.

Mance proceeds to point out several applications of this method, concluding, 'lastly, this method may be used to ascertain the internal resistance of a battery.' There is nothing difficult or uncertain in this presentation and it seems strange that this original simplicity should have been so completely lost by later writers.

The clearest discussion of this method that I have seen in print is that given by Lodge in the paper referred to above, but this is descriptive rather than mathematical. However, he introduces a modification of the method which greatly increases the range of its application. This consists in using a condenser in series with the usual galvanometer, so as to detect variations in difference of potential instead of variations in current. By this means the method becomes a null one, and, moreover, the measurements can be made in a much shorter time as there is no waiting for the needle to come to rest in its deflected position. This is of especial advantage with cells which polarize rapidly. To eliminate the effect of any change in E.M.F. after the circuit is closed, Lodge devised a special key which broke the galvanometer connection immediately after the bridge circuit is made. It is better, however, to use a short-circuiting key on the galvanometer as suggested by Guthe.[3] The key is opened just before the discharge passes through the galvanometer and closed immediately afterwards to avoid any changes due to a variation in the E.M.F. of the cell.

However, as all cells polarize more or less rapidly, especially just after closing the cir-

[3] K. E. Guthe, 'Laboratory Exercises,' 1903.

cuit, it is not possible to work all the keys by hand quickly or uniformly enough to obtain the best results. By using a two-pole multi-circuit switch the various keys can be combined in one, and a single motion of the hand works them all in the order required. The switch *s* (Fig. 4) consists of two blades, *m*

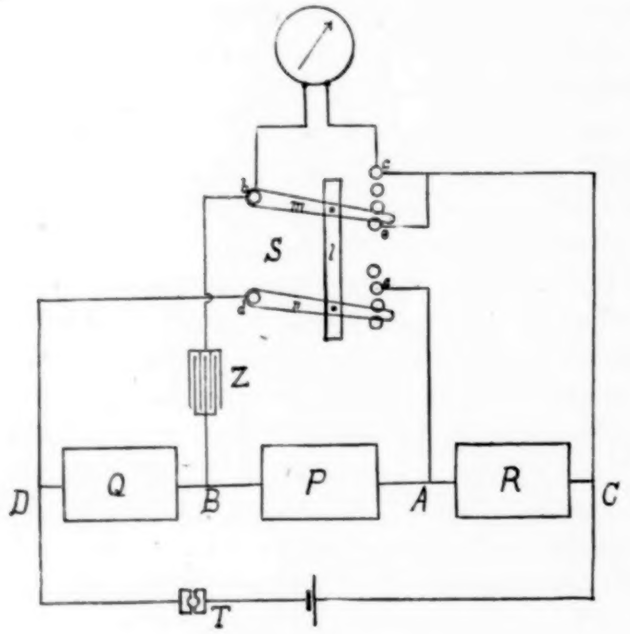

FIG. 4.

and *n*, pivoted at *b* and *d* and both moved by the connecting piece, *l*, over a series of four contact points. Thus, used as a two-pole switch, *b* and *d* can be connected to any one of four different circuits; but in the present case only a few of the contacts are utilized, and these are connected so as to make and break the various connections in the order desired as the switch is quickly moved from one side to the other.

The arrangement then is as follows: The cell, or other resistance to be measured, is joined in series with three resistances, *R*, *P* and *Q*, Fig. 4. The points *A* and *D* are joined to *a* and *d*, and are connected whenever *n* rests upon the third contact point. The galvanometer is joined to the points *b* and *c*, while *c* and *e* are permanently connected, thus short-circuiting the galvanometer when contact is made on either point, but when *m* is moved from *e* to *c* the short-circuit is raised for an instant. It is during this instant that the points *a* and *d* are connected by *n* passing over its third contact.

The points *b* and *c* are also joined to *B* and *C*, the former through the condenser *Z*. When the key *T* is closed this condenser is charged to the difference of potential between *B* and *C*, the charge passing through the blade *m* and leaving the galvanometer at rest. When the switch is thrown over to the third point, *A* and *D* are connected, which practically cuts *P* and *Q* out of the circuit, leaving only the battery and *R*. With this shorter circuit the condenser is charged to the difference of potential between *A* and *C* (since *D*, *B* and *A* are all at the same potential) and if this is the same as that formerly existing between *B* and *C* there will be no change in the charge and, therefore, no deflection of the galvanometer which, for this position of the switch, is not short-circuited. As the switch is moved further the galvanometer is short-circuited again before the connection *ad* is broken, thus eliminating the back kick of the galvanometer as the charge in the condenser returns to its former value.

Having set up the apparatus as indicated in the figure, the manipulation is as follows: The key *T* is closed and the switch quickly moved from *e* to *c*. If there is a deflection of the galvanometer the key is opened, the switch set back to its first position, and the values of *P* and *Q* changed until zero deflection is obtained when the switch is thrown. The arrangement is then 'balanced' and $X = R\,Q/P$.

This relation is easily deduced. The potential to which the condenser is charged in the first case, viz., that between *B* and *C*, is

$$e = I(R+P) = \frac{E(R+P)}{R+P+Q+X}$$

where *E* is the E.M.F. of the cell and *X* its resistance. When *P* and *Q* are short-circuited the condenser is charged to the difference of potential between *A* and *C*, which is

$$e' = RI' = \frac{ER}{R+X}.$$

When the galvanometer shows no deflection, $e = e'$, or

$$\frac{R+P}{R+P+Q+X}=\frac{R}{R+X},$$

which readily gives the relation

$$X=R\frac{Q}{P}.$$

It is true this result appears in the same form as that deduced for the Wheatstone bridge, but beyond a superficial analogy there is nothing in common between the two methods. The Wheatstone's bridge method consists in dividing two parallel circuits in the same ratio. Mance's method, on the other hand, consists in subtracting from the two portions of a single circuit such resistances that the two portions shall still maintain the same ratio to each other.

In this connection it may be of interest to look at the results of a few measurements by this method. The resistance measured consisted of a medium-sized storage cell in series with a coil marked '2 ohms.' This gives a definite resistance with an E.M.F. not easily polarized. The results of thirty measurements are shown in the table below. R was varied from one ohm to forty ohms, and P was given such values that Q would be a little over 4,000 ohms. Each balance was sensitive to a change of 1 ohm in Q, and often the 0.5-ohm coil was used. The results are tabulated in the order obtained, reading across the table from left to right. As the room became warmer the resistance grew larger, each column showing the same increase of 0.002 ohm. It is seen from these results that the method is as sensitive as a post-office box, and by using a larger condenser the sensitiveness can be still further increased. From this limited data it is hardly safe to draw a general conclusion, but it may be noted that the smaller values of R, in other words, the larger currents in the storage cell, give smaller values of X, the same as with ordinary cells.

Temperature of Room.	Resistance of '2 Ohms' Plus Storage Cell.					
	$R=1.$	$R=2.$	$R=3.$	$R=4.$	$R=10.$	$R=40.$
12.°0	2.0265	2.0280	2.0295	2.0295	2.0300	2.0300
12.°6	2.0265	2.0290	2.0305	2.0310	2.0315	2.0320
13.°0	2.0280	2.0297	2.0315	2.0312	2.0315	2.0320
13.°2	2.0282	2.0300	2.0315	2.0315	2.0317	2.0320
13.°5	2.0285	2.0302	2.0315	2.0315	2.0317	2.0320

The following results were obtained from a large 'Gonda' cell, a porous cup type of Leclanche cell. It had been in constant use in the laboratory for five months with no change of electrolyte. As it polarized rapidly for the first ten seconds after closing the circuit through one or two ohms, its resistance was measured with values of R of 40, 60 and 80 ohms. The values obtained were as follows:

Temperature of Cell.	Resistance of 'Gonda Cell.'		
	$R=40.$	$R=60.$	$R=80.$
13.°0	1.388	1.386	1.388
	1.392	1.392	1.388
	1.392	1.392	1.384
13.°2	1.389	1.392	1.388

The average of these twelve determinations is 1.389 ohms, and the mean variation from this value is 0.002 ohm, while the probable error of this result is 1 part in 2,600.

But it is not my present purpose to discuss experimental data except in so far as it shows that Mance's method is not without some merit. It has been shown that this method is fully as accurate as is required for laboratory use, whether the resistance to be measured be of the first or second class. The purpose of this paper will be fully attained if it has clearly shown the principle underlying this method, and pointed out the very obvious error which has crept into many of the text-books from Maxwell down to the present.

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ANN ARBOR, MICH.,
February 11, 1905.

ORGANISMS ON THE SURFACE OF GRAIN, WITH SPECIAL REFERENCE TO BACILLUS COLI.

THE recent note by Dr. Erastus G. Smith on the occurrence on grain of organisms resembling the *Bacillus coli communis*[1] appears to warrant preliminary publication of some of the results of my studies of the micro-organisms normally present on the flowers and fruit of certain plants in the Piedmont region and the rice belt of South Carolina. These studies, originally undertaken as a side issue

[1] SCIENCE, May 5, 1905.

in another problem, have proved intrinsically interesting.

In the fall of 1903 I determined the organisms present on the grain in twelve rice fields. In 1904 I studied both the flowers and grain in eight of the twelve fields examined the year before, and in four other fields. In 1904 I also studied, for comparison, the flowers and grain in eight wheat fields, and six oat fields; also the flowers and fruit in three peach orchards, flowers and fruit in two asparagus patches, and flowers and fruit in one patch of the wild *Iris verna* L. A few comparative studies of organisms on the fruit or flowers and the leaves of the same plant were also made. In every case exactly fifty grains or flowers or fruits, as the case might be, were taken at random from each field or patch, in the case of the cereals only one grain from any one spike. Each one was shaken in sterile water, allowed to stand for about an hour, shaken again, and the whole added to sterile agar-agar and plated; except in the case of peaches, when only a portion of the water was plated. The resulting organisms were studied in greater or less detail, according to their interest.

A part of the conclusions to date are as follows:

1. An immense but variable number and variety of micro-organisms were normally present on the surface of flowers, fruits and leaves. These were different in different localities, and different in successive years in the same locality, and showed no constant association with the host plants studied.

2. Without exception, the same organisms that occurred on the flower could later be found on the fruit, but not in the same quantity. But organisms commonly occurred on the fruit that were not found on the flower.

3. The most constantly present organisms were certain yeasts: in greatest number and variety on the peach, asparagus and iris; but yet characteristically present on the cereals.

4. The bacteria on the flowers and fruit were not different in kind from those on the leaves of the same plant, nor, so far as studied, materially different in number, area for area. With the peach, asparagus and iris fungi, and especially yeasts, occurred in noticeably greater number on the flower and fruit than on the leaf.

5. Bacteria giving the standard reactions of the colon group were found in thirteen out of the sixteen rice fields examined, five of the eight wheat fields and all of the oat fields. All three peach orchards and both asparagus patches exhibited coli forms in both flower and fruit; but none were found on either flower or fruit of *Iris verna*. In the following tables are shown the proportion of flowers and fruits (each flower or grain in the cereals representing a spike) found to have coli forms on the surface:

Rice: No. of Field.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Per cent. of spikes with coli forms, 1903.	0	10*	2	16	20	0	26	32	0	30*	0	6	—	—	—	—
Ditto, flowers, 1904	0	—	22*	8	38	4	—	8*	6	—	0	—	10	48*	6	0
Ditto, grains, 1904.	0	—	48*	4	52	8	—	14*	2	—	0	—	28	30*	4	0

Wheat: No. of Field.	1	2	3	4	5	6	7	8
Per cent. of spikes with coli forms, flowers	6	4	0	14*	0	0	8	26*
Ditto, grains	2	6	0	22*	0	0	2	18

Peaches: No. of Orchards.	1	2	3
Per cent. of flowers with coli forms	16*	8*	20
Ditto, fruits	24*	12*	14

Oats: No. of Field	1	2	3	4	5	6
Per cent. of spikes with coli forms, flowers	6	8	2*	14*	34	4
Ditto. grains	2	0	4	10	28	2

Asparagus: No. of Patch.	1	2
Per cent. of flowers with coli forms	58*	26
Ditto, fruits	40	16

An asterisk indicates that there were in the field in question very obvious means of contamination by human or animal excrement at

the time the plates were made. In the other fields the source of the coli forms was without doubt the excrement deposited by draft-animals in working the ground, to say nothing of that deposited on the banks and adjacent secluded spots by workmen. Indeed, the non-occurrence of coli forms in certain fields seems most difficult to explain.

These studies are being continued, and when completed, will be published probably in the *Centralblatt für Bakteriologie*.

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SOUTH CAROLINA.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.[1]

IN 1903 I was appointed by the council of this society acting as the regional bureau for New South Wales, to represent this state at the council meetings held in London in May last. I duly attended the meetings and now have the honor to make the following report. The Royal Society of London commenced the work by compiling catalogues of scientific papers (printed between 1800 and 1883) in twelve large quarto volumes, the first volume of which was issued in 1867. In it the titles are arranged solely under the authors' names. A catalogue of the papers published since, *i. e.*, between 1884 and 1900, is now in hand, and a subject index is also nearly completed.

The possibility of preparing a complete catalogue of current scientific literature was considered by the Royal Society in 1893, but as it was apparent that the work was beyond the resources of the Royal Society, or indeed of any single body, the society sought the opinion of representative foreign bodies and individuals, and the replies being favorable, steps were taken to summon an international conference. This conference, at which I was present as a delegate, took place in London, on July 14 to 17, 1896, and was attended by delegates appointed by the governments of Canada, Cape Colony, Denmark, France, Greece, Hungary, India, Italy, Japan, Mexico, Natal, the Netherlands, New South Wales, New Zealand, Norway, Queensland, Sweden, Switzerland, the United Kingdom and the United States. It was then unanimously resolved to compile and publish a complete catalogue of current scientific literature, arranged according to both subject matter and authors' names. The Royal Society was requested to appoint a committee to further consider the system of classification to be adopted and other matters, and it was decided to establish the central bureau in London.

At the second international conference held in London on October 11 to 13, 1898, several questions were settled and a provisional international committee appointed which afterwards met in London, on August 1 to 5, 1899, when the work was still further expedited and the Royal Society requested to organize the central bureau and make all necessary arrangements so that the preparation of the catalogue might be commenced in 1901.

A third international conference was held in London, on June 12 and 13, 1900, at which all financial and other difficulties were removed by the Royal Society agreeing to act as publishers and to advance the funds necessary to start the enterprise. The supreme control over the catalogue is now vested in an international convention which is to meet in London in 1905, in 1910 and every tenth year afterwards, to consider and, if necessary, to revise the regulations for carrying out the work of the catalogue. In the interval between two successive meetings of the convention the administration of the catalogue is carried out by the international council, the members of which are appointed by the regional bureaus.

The total expenditure from July 1, 1900, to February 29, 1904, has been £10,153, and the total amount received from subscribing bodies was £6,755; eventually the publication will pay its way, but it may be some time before the debt to the Royal Society will be extinguished. The financial support given by the different countries is shown in the following list. New Zealand has not become a contracting body: Austria, £165; Canada, £119; Cape Colony,

[1] Report presented at the annual general meeting of the Royal Society of New South Wales, May 3, 1905.

£109; Denmark, £102; Egypt, £17; Finland, £45; France, £754; Germany, £901; Greece, £34; Holland, £133; Hungary, £68; India and Ceylon, £471; Italy, £459; Japan, £255; Mexico, £85; New South Wales, £34; New Zealand, £17; Norway, £85; Nova Scotia, £17; Orange River Colony, £17; Poland, £17; Portugal, £17; Queensland, £34; Russia, £512; South Australia, £34; Sweden, £85; Switzerland, £119; United Kingdom, £765; United States, £1,251; Victoria, £17; Western Australia, £17. Total, £6,755.

	Slips.	Instalments.
Germany	146,552	59
France	46,702	38
United Kingdom	43,484	166
United States	37,688	68
Russia	21,071	5
Italy	13,473	25
Holland	6,657	17
Austria	6,379	2
Poland	3,492	8
India and Ceylon	2,231	39
Japan	2,208	10
Switzerland	1,932	7
Hungary	1,745	4
Denmark	1,722	17
Sweden	1,457	4
Victoria	1,445	3
Norway	1,303	12
New South Wales	1,016	5
Finland	707	8
South Africa	645	4
Belgium	584	2
Canada	537	11
New Zealand	327	3
South Australia	130	4
Western Australia	16	1
	343,503	522

It has been suggested that special efforts should be made by the regional bureaus to bring the catalogue under the notice of scientific workers, and to secure an increase in the number of subscribers. The whole of the first and second issues of the 'International Catalogue of Scientific Literature' have been published with the exception of the volumes on botany and zoology; the third annual issue is in preparation and several of them are already in the press. The number of entries in the author catalogue of the first annual issue was 43,447, and the total number of entries in that issue was 149,768. The numbers of books and papers indexed in the volumes of the second annual issue are as follows: A, mathematics, 1,843; B, mechanics, 841; C, physics, 2,433; D, chemistry, 5,632; E, astronomy, 1,223; F, meteorology, 1,988; G, mineralogy, 1,307; H, geology, 1,702; J, geography, 2,022; K, paleontology, 638; L, general biology, 689; M, botany, 6,339; N, zoology, 7,131; O, anatomy, 1,424; P, anthropology, 1,861; Q, physiology, 9,671; R, bacteriology, 3,132. The total number of entries in the author catalogue of the second annual issue is, therefore, 49,876, an increase of 6,429, or about 15 per cent. more than the number in the first annual issue. The total number of pages in the first annual issue is 8,387.

The foregoing table shows the number of slips *received* and the instalments in which they were supplied to the central bureau.

It was originally intended that the catalogue should not only contain the titles of papers, but that their subject matter should be fully indexed also; financial considerations have, however, led to the number of subject entries being at present limited in number. The title slips received at the central bureau very often showed that the papers were insufficiently indexed, especially in the lists of new species in botany, zoology and chemistry; in many cases the central bureau has made good these deficiencies. The executive committee urge that efforts should be made in all countries to supply fuller information as to the contents of papers; if this were done the catalogue would be much more complete and the cost would be much decreased, and all journals are urged to index each paper and attach the registration numbers at the time of publication.

At the meeting of the international council held at the Royal Society's House, London, May 23 and 24, 1904, it was resolved, in consequence of the success achieved by the 'International Catalogue of Scientific Literature,' and of its great importance to scientific workers, to recommend that its publication be continued. The agreement with the contract-

ing countries was made in the first instance for five years only, in case the publication of the catalogue should fail financially or in other ways. It was also decided to spend £100 in making the catalogue known, and to take steps to invite the cooperation of other countries not yet represented on the council, *e. g.*, Spain, the Balkan States, South American Republics, etc.

The proposal to publish additional volumes upon, *a*, medicine and surgery; *b*, agriculture, horticulture and forestry; *c*, technology (various branches) was discussed, and it was decided that the executive committee should take the suggestion into fuller consideration and bring it under the notice of the international convention in July, 1905. It was also resolved that all alterations in the schedules should be collected and edited by the central bureau prior to submission to the regional bureaus for their opinions, and that the schemes should be edited by a special committee before being submitted to the international convention.

A. LIVERSIDGE.

INAUGURATION OF THE MAGNETIC SURVEY OF THE NORTH PACIFIC OCEAN.

As announced in a previous issue of SCIENCE, the brig *Galilee* of San Francisco, a wooden sailing vessel, built in 1891, of length 132.5 feet, breadth 33.5 feet, depth 12.7 feet, displacement about 600 tons, has been chartered by the department of terrestrial magnetism of the Carnegie Institution of Washington for the purpose of making a magnetic survey of the North Pacific Ocean. After the various necessary alterations, *e. g.*, substitution of the steel rigging by hemp rigging, etc., were made, the vessel entered upon her duties early in August. Magnetic observations were made at various places on the shores around San Francisco Bay and the most suitable place for 'swinging ship' by their aid determined. The ship was 'swung' with the aid of a tug on August 2, 3 and 4 in San Francisco Bay between Goat Island and Berkeley, California, and the various deviation coefficients were determined.

On August 5, the *Galilee* sailed from San Francisco, secured magnetic observations daily to a greater or less extent according to conditions of the weather and sea, 'swung' twice under sail, and arrived at San Diego, August 12. This first short cruise was an experimental one, various instruments and methods having been subjected to trials under the direction of the writer, who accompanied the expedition as far as San Diego. The deflection apparatus devised by the writer for determining horizontal intensity has proved successful. In a future paper the methods, instruments and results will be more fully described.

After further alterations had been made at San Diego, and the deviation coefficients having been redetermined, the *Galilee* again set sail, on September 1, this time for the Hawaiian and Midway Islands and is expected to return to San Francisco about December 1. After these two experimental voyages, she is to sail from San Francisco early in 1906 on a more lengthy cruise—one embracing the entire circuit of the North Pacific Ocean.

The scientific personnel at present consists of Mr. J. F. Pratt, commander; Dr. J. Hobart Egbert, surgeon and magnetic observer; Mr. J. P. Ault, magnetic observer, and Mr. P. C. Whitney, magnetic observer and watch officer. The sailing master is Captain J. T. Hayes, who has made some record sailing trips in the *Galilee*—one a voyage of 3,000 miles from the South Pacific Islands to San Francisco in fifteen days and having made as much as 308 miles in one day.

L. A. BAUER.

DEPT. TERRESTRIAL MAGNETISM,
CARNEGIE INSTITUTION,
WASHINGTON, D. C.,
September 11, 1905.

EXPERIMENTAL STUDIES IN YELLOW FEVER AND MALARIA AT VERA CRUZ.

THE U. S. Public Health and Marine Hospital Service has published a bulletin on the experimental work done by assistant surgeons M. J. Rosenau, Herman B. Parker, Edward Francis and George E. Beyer, the conclusions of which are as follows: The cause of yellow fever is not known. The *Myxococcidium*

stegomyiæ is not an animal parasite. Yeast cells sometimes stimulate the coccidia in form and staining reaction.

The infection of yellow fever is in the blood serum early in the disease. No abnormal elements that bear a causal relation to the disease can be detected in the serum or in the corpuscles with the best lenses at our command.

The infective principle of yellow fever may pass the pores of a Pasteur-Chamberland B filter. Particles of carbon visible with Zeiss lenses pass through both the Berkefeld and Pasteur-Chamberland B filters. Because the virus of an infectious disease passes a Berkefeld or Pasteur-Chamberland B filter it does not necessarily follow that the parasite which passed the filter is 'ultramicroscopic,' or that it may not have elsewhere another phase in its life cycle of large size. The filtration of viruses may succeed or fail, depending upon the character of the filter, the diluting fluid, the pressure, time, temperature, motility of the particles and other factors.

The period of incubation of yellow fever caused by the bites of infected mosquitoes is usually three days, sometimes five days, and in one authentic instance six days and two hours; but when the disease is transmitted by such artificial means as the inoculation of blood or blood serum the period of incubation shows less regularity.

Yellow fever may be conveyed to a non-immune by the bite of an infected *Stegomyia fasciata;* but the bites of *Stegomyia* which have previously (over twelve days) bitten cases of yellow fever do not always convey the disease.

Fomites play no part in the transmission of the disease.

The tertian and estivo-autumnal malarial parasites will not pass the pores of a Berkefeld filter.

There is a poison in the blood during the chill of tertian infection which, when injected into another man, caused chill, fever and sweating. This poison, while present in a case of tertian during the rise of temperature, could not be demonstrated in the blood of a case of estivo-autumnal fever during the decline of the paroxysm. While this poison reproduced the symptoms of the disease, still the data are too limited to consider it the malarial toxin.

Stegomyia fasciata is a domestic insect. It is most active during the day, but will bite at night under artificial light. The female lays eggs at intervals; the maximum number of eggs laid by one insect observed was 101. The mosquito does not always die directly after ovipositing.

Stegomyia fasciata may bite and draw blood from cadavers, although the danger from spreading the infection from this source is remote.

Male and female *Stegomyia fasciata* may pass a screen containing 16 strands, or 15 meshes to the inch, but not one of 20 strands, or 19 meshes to the inch.

Tobacco smoke produced by burning two pounds per 1,000 cubic feet with an exposure of two hours is sufficient to kill *Stegomyia fasciata.* This method is objectionable on account of the yellow stains and disagreeable odor. Pyrethrum burned in the proportion of one pound per 1,000 cubic feet with an exposure of two hours will stupefy *Stegomyia fasciata;* it requires two pounds to kill them outright.

From the limited number of experiments made and from previous experiments it is thought that sulphur dioxid is the best of the gaseous insecticides for this purpose. Formaldehyde gas is not an insecticide, and therefore not applicable.

SCIENTIFIC NOTES AND NEWS.

M. Élie Metchnikoff, of the Institut Pasteur, has been elected a foreign member of the Brussels Academy of Sciences.

Dr. Karl Schwarzschild, professor of astronomy at Göttingen, has been elected a member of the Academy of Sciences of that city.

Brig. General A. W. Greely, chief signal officer of the army, has completed a thorough inspection of the Alaskan telegraph system.

Dr. Otto Klotz, Dominion astronomer, has just completed observations at Harvard Observatory for the longitude connections with the new observatory at Ottawa.

PROFESSOR PODWYSSOTZKI, dean of the medical faculty of Odessa, has been appointed director of the Institute for Experimental Medicine at St. Petersburg.

DR. HERMAN S. DAVIS, after six years' investigation of the variations of latitude for Columbia University, New York, and five years' for the International Geodetic Association, retires from this line of research on November 1, on which date his resignation as director of the observatory at Gaithersburg, Maryland, takes effect.

THE following members of the advisory board of Panama Canal engineers have sailed for the Isthmus on the steamship *Colon:* Gen. George W. Davis; William Barclay Parsons; Professor W. H. Burr, of Columbia University; Gen. Henry H. Abbott; Eugene Tincauzer, German delegate; Edouard M. Quellenac, of the Suez Canal staff; Isham Randolph; F. P. Stearns; Joseph Ripley; W. H. Hunter, of the Manchester Canal; Adolph Guerard, French delegate; J. W. Welcker, Dutch delegate, and Capt. John C. Oakes, secretary.

A CABLEGRAM from London states that William P. Byrne, principal clerk of the home office; Dr. Horatio B. Donkin, a commissioner of prisons and consulting physician to Westminister Hospital; Dr. William H. Dickinson, consulting physician to St. George's Hospital and former president of the Royal Medical and Chirurgical Society; J. C. Dunlop and Mrs. Pinsent, composing the sub-committee of the Royal Commission on the care and control of the insane, sailed from Liverpool for New York, on September 30, on the Cunard Line steamer *Etruria,* to investigate American methods of treating the insane.

DR. H. P. BOWDITCH, professor of physiology at the Harvard Medical School, has been granted leave of absence for the coming year.

THE Herter Lectures, established by Dr. C. A. Herter at the New York University and Bellevue Hospital Medical College, will be given this year by Professor Carl von Noorden, chief of the City Hospital, of Frankfort, Germany. His subject will be 'Diabetes.' The lectures, six in number, will be given in English in the large auditorium of the Carnegie Laboratory, 338 East 26th Street, October 9 to 14, inclusive, at 4 o'clock in the afternoon. Visitors are welcome to these lectures. Reserved seats are to be had on application to the college.

AT the first fall meeting of the New York Academy of Sciences, Professor Robert W. Hill will lecture on 'The Republic of Mexico, its Physical and Economic Aspects.' The lecture will be given in the large lecture hall of the American Museum of Natural History, and all interested are invited to attend.

THE Harben Lectures of the Royal Institute of Public Health will be delivered in the lecture room of the institute, on October 10, 12 and 17, by Professor Thomas Oliver, physician to the Royal Infirmary, Newcastle-on-Tyne. The subject of the lectures will be, 'Some of the Maladies caused by the Air we Breathe in the Home, Factory and the Mine, including a Description of Caisson Disease or Compressed Air Illness.'

PROFESSOR WILLIAM OSLER, regius professor of medicine at Oxford University, has accepted the post of Thomas Young lecturer on medicine at St. George's Hospital, and will give a series of lectures and demonstrations at the hospital next spring on the diagnosis of abdominal tumors.

DR. A. M. FAIRBAIRN, principal of Mansfield College, Oxford, England, who has accepted an appointment as Deems lecturer at New York University, will deliver his course of lectures in January.

PROFESSOR CHARLES SCHUCHERT, of Yale University, has returned from a geological trip extending over the ancient formations of Nova Scotia, New Brunswick and eastern Quebec.

A CABLEGRAM to the daily papers states that Mylius Ericksen is preparing a Danish ship and a sledge party for an expedition to the hitherto unexplored regions of the northeastern coast of Greenland. The plans have been in course of elaboration since Ericksen's return from his last expedition, and have been approved by many societies, including the American Geographical Society and the Royal

Geographical Society of London, and also by Dr. Nansen, Professor von Drygalski and other scientific men.

American Medicine states that during the epidemic in New Orleans an opportunity has been afforded for careful study of conditions leading to the infection, with the result, it is believed, that the causative microorganism has been isolated and identified. The work has been conducted at the emergency hospital by Drs. P. E. Archinard, J. Birney Guthrie and J. C. Smith. The life history of the organism discovered by Dr. Archinard has been followed, and its presence in the blood of patients confirmed.

SIR THOMAS BROWNE, the author of 'Religio Medici,' was born on October 19, 1605, and the quatercentenary will be celebrated at Norwich on the same date this year. *The British Medical Journal* states that the memorial statue of Sir Thomas Browne, erected in the Market Place, will be unveiled at 12:30 P.M. by Lord Avebury, F.R.S.; afterwards a luncheon will be held at the Blackfriars Hall. At 8:30 P.M. there will be a service in memory of Sir Thomas Browne in the Church of St. Peter Mancroft, Norwich, near which he lived for many years, and in which he worshipped, and lies buried; the sermon will be preached by the Right Rev. Bishop Mitchinson, master of Pembroke College, Oxford, of which college Sir Thomas Browne was a member.

DR. ALFRED SCHAPER, assistant to the professor of embryology at Breslau, has died at the age of forty-two years.

THE deaths are also announced of Dr. Franz Ruch, docent in geodesy in the Technical Institute at Prague, and of Dr. Rudolf Pernthner von Lichtenfelds, docent in architectural engineering in the Polytechnic Institute at Vienna.

THE second general international sanitary convention will meet in Washington on October 9. The different South American republics will be represented, and many European men of science will be in attendance.

A CIVIL SERVICE examination will be held October 25, 1905, to establish a register of eligibles from which to fill four positions as laboratory assistant in the Bureau of Standards, Washington. Three of these positions are in the Electrical Division of the Bureau and one in Weights and Measures; the salaries are $900 and $1,000. The examination will consist of:

Education and experience (rated on application form)	50
General physics	25
Special subjects (it is optional with the competitor to take more than one of these subjects)—(*a*) electrical measurements; (*b*) weights and measures	25
Total	100

Any one wishing to take the examination should address the U. S. Civil Service Commission requesting application blanks. Further information may be obtained by addressing the director of the Bureau of Standards. Applicants must be between 20 and 35 years of age.

THE Smithsonian Institution has received information through the Department of State, from Consul General George Heimrod, of Apia, Samoa, that between August 2 and 4, last, a new volcano broke out in Savaii, about eight miles east of the old volcano Mangi, and ten miles south of Matautu. Mr. Heimrod states that the activity of this volcano is phenomenal, as in a single fortnight it created a new mountain with three peaks, one of which will soon reach a height of 800 feet or 2,000 feet above sea-level. The ejected matter represents many millions of tons of unsmelted rocks, slag, cinders and ash, which at the beginning of the outbreak in its fiery state was moving towards the sea, the settled part of the island. The mass is about five miles long and one fourth of a mile wide, and as it has almost come to a standstill and is hardening at its extreme ends, danger for life and property is not anticipated.

IN connection with the Conservatoire des Arts et Métiers a museum of industrial hygiene will be opened this month at Paris by the president of the republic.

ACCORDING to *The Journal of the Society of Arts* the British consul at Naples reports that the work on the new wing which is being

added to the Stazione Zoologica is making rapid progress. When completed the capabilities of the institution for scientific investigation in connection with fishing and other questions will be more than doubled, and the extension would seem to be much wanted, for during the spring months of the present year no less than seventy naturalists of all nationalities were engaged in various researches, and fifteen applicants had to be refused admission on account of the lack of accommodation. The completion of the new building, the ground plan of which measures 110 by 77 feet, will permit the following improvements to be made: (1) The unique library of books on marine biology will be brought together upon the same floor instead of being distributed in various rooms; (2) laboratories and workrooms equipped under the superintendence of Dr. Henze for research in the physiological chemistry of marine animals will be the best and largest of their kind, and will occupy the second floor of the new building; (3) laboratories and workrooms for other physiological work in connection with marine animals will occupy the first floor; (4) a new photographic and artists' room will be gained; (5) a bacteriological laboratory; (6) some thirty new rooms for private study. The basement will be occupied by enormous aquaria and tanks, with the necessary engines for working the circulating pumps and for supplying power to the engineer's shop.

THE Wagner Free Institute of Science, Philadelphia, announces the following courses of lectures: Professor Samuel T. Wagner, 'Roads, Railroads and Tunnels'; sixteen lectures, as follows: September 15, 22, 29; October 6, 13, 20, 27; November 3, 10, 17, 27; December 1, 8, 15, 22, 29. Dr. Philip P. Calvert, 'The Development and Life Histories of Invertebrate Animals'; ten lectures, as follows: October 2, 9, 16, 23, 30; November 6, 13, 20, 27; December 4. Professor Henry Leffmann, 'Metals and Ores'; ten lectures, as follows: October 4, 11, 18, 25; November 1, 8, 15, 22, 29; December 6. Professor Wm. B. Scott, 'Physiographical Geology'; sixteen lectures, as follows: January 3, 10, 17, 24, 31; February 7, 14, 21, 28; March 7, 14, 21, 28; April 4, 11, 18. Professor Geo. F. Stradling, 'Electricity'; sixteen lectures, as follows: January 5, 12, 19, 26; February 2, 9, 16, 23; March 2, 9, 16, 23, 30; April 6, 20, 27. Dr. John W. Harshberger, 'North American Trees'; ten lectures, as follows: February 5, 12, 19, 26; March 5, 12, 19, 26; April 2, 9.

THE policy of holding annually a meeting of the principal engineers of the Reclamation Service for the purpose of discussing matters of administration and economies of work seems to have become well established. The reclamation act was signed by the president, on June 17, 1902. An engineering corps consisting of well-trained and experienced men has been gradually selected through the Civil Service Commission to meet the needs of the service, and the work of reclamation has been energetically pushed in all parts of the arid region. The first conference of engineers was held at Ogden, Utah, September 15 to 18, 1903, in connection with the eleventh Irrigation Congress. The first session of the second conference was held at the time of the meeting of the twelfth Irrigation Congress, at El Paso, Texas, November 14 to 18, 1904. On this occasion the principal engineers of the Reclamation Service met prominent citizens from the west and exchanged views with them regarding reclamation matters of common interest. The conference adjourned to meet in Washington in January, 1905, in order to allow opportunity for other engineers to take part in the discussions and to give additional time for consideration of important details. At the adjourned meeting in Washington a number of prominent public men met the engineers and exchanged views concerning matters in various states. The discussions that occurred at this meeting and the papers presented then constitute a very valuable body of material. The printed report of the proceedings of the first conference, that at Ogden, was distributed as Water-Supply and Irrigation Paper No. 93 and was found to be of great assistance to the men engaged in reclamation work. On the recommendation, therefore, of Mr. F. H. Newell, chief engineer,

the proceedings of the second conference have been collected and published by the United States Geological Survey. They are now available as Water-Supply and Irrigation Paper No. 146, and may be obtained free of charge on application to the director of the Survey, Washington, D. C. Besides data concerning the organization of the hydrographic branch of the Geological Survey and the Reclamation Service, the paper contains the minutes of the conference at El Paso and the conference at Washington, the address of the chief engineer, the papers read at the conference, committee reports, circulars relating to a variety of subjects, and brief biographical sketches of all persons employed in the Reclamation Service.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. James Millikan, who has given $900,000 for the establishment of a university at Decatur, Ill., which shall bear his name, has offered to give a further million dollars to the institution.

Major Henry E. Alvord, the late chief of the dairy division of the Department of Agriculture in Washington, divided his library between Norwich University, of Vermont, his alma mater, and the Massachusetts Agricultural College at Amherst. To the latter institution he bequeathed also a fund of $5,000 for an Alvord dairy scholarship. This, however, is subject to the life interest of his widow.

According to the *New York Evening Post* Dr. Kisaburo Yamaguchi, an official in the Central Office of Mines, Tokio, has announced that Johns Hopkins will be made the recipent of an extensive collection of Japanese minerals.

Dr. John N. Tillman was inaugurated as president of the University of Arkansas, at the opening of that institution, on September 20.

Dr. William Louis Poteat, for some years professor of biology in Wake Forest College, North Carolina, was recently elected president of the same institution. It is proposed to have the inaugural exercises in December.

At the University of Illinois James McLaren White, professor of architectural engineering, has been appointed acting dean of the College of Engineering; Edgar J. Townsend, associate professor of mathematics, acting dean of the College of Science, and Dr. Edwin G. Dexter, professor of education, director of the School of Education. Appointments have further been made as follows: Professor S. E. Slocum, assistant professor of mathematics; F. O. Dufour, of Lehigh University, assistant professor of civil engineering; C. H. Hurd, University of Chicago, assistant professor of applied mechanics; Edward O. Sisson, formerly director of Bradley Polytechnic Institute, Peoria, and Frank Hamsher, principal of academy, assistant professors of education; Dr. Edward Barto, associate professor of chemistry and director of water survey; W. J. Risley, University of Michigan, instructor in mathematics and astronomy; John Watrous Case, Massachusetts Institute of Technology, instructor in physics.

Dr. Leo F. Guttman, of London, for two years research assistant to Sir William Ramsay, has arrived from abroad to take up his duties as Carnegie research assistant to Professor Charles Baskerville, of the College of the City of New York, in his chemical investigations of the rarer earths.

Dr. Wilhelm F. Koelker, who recently took his degree with Professor Emil Fischer at the University of Berlin, has been appointed instructor in organic chemistry at the University of Wisconsin.

Mr. C. G. Eldredge, of Sabula, Iowa, has been appointed assistant in the chemical department of Cornell College.

Dr. H. A. Higbee and Dr. Roger C. Wells have been appointed instructors in physics in the University of Pennsylvania.

Provision has been made for a professorship of botany at the University of Melbourne and for the erection of a botanical laboratory.

Dr. Konrad Dietrici, of Hanover, has been called to the chair of physics at Rostock.

Professor O. Pumlirz, of Czernowitz, has been called to the chair of mathematical physics at Innsbruck.